

What I have said are generalizations very incomplete, yet they, nevertheless, indicate that the practice of agriculture and horticulture has taken a highly mechanical and scientific tone, a pursuit worthy of the most intelligent mind.

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*Stated Meeting May 18, 1906.*

President SMITH in the Chair.

Dr. J. W. Harshberger and Mr. Russell Duane, newly elected members, were presented to the Chair and took their seats in the Society.

A letter was read from Prof. Theodor Nöldeke accepting membership.

The decease was announced of the following named members:

Richard Garnett, C.B., LL.D., at London, on April 1, 1906, æt. 68.

Prof. E. Renevier, at Lausanne, Switzerland, on May 5, 1906.

Hon. Carl Schurz, at New York, on May 11, 1906, æt. 77.

The following letter was read by PROF. GEORGE DAVIDSON, of San Francisco:

POINTS OF INTEREST INVOLVED IN THE SAN FRANCISCO EARTH-  
QUAKE.

At the request of your Secretary I draw up this short account of some of the points of interest involved in the earthquake and conflagration of San Francisco.

I hardly know what I have already written, or where to begin to tell a coherent story, although a thousand facts have been seared upon my brain. I see the flames rising yet, 500 feet above the earth.

It really seems very long since the earthquake aroused us: it would have been forgotten by this time. It is the conflagration, its awful grandeur, and its ruin of tens of thousands of people, that staggers us with its horror, and its consequences. But San Francisco will arise from this supreme blow. We are to control the Pacific.

I cannot do better than to first give you a broad idea of the geography and orography of this part of the State; and of the ocean washing it. The general direction of the coast range of mountains is northwest and southeast from Cape Mendocino in latitude  $40^{\circ} 27'$  to Point Conception in  $34^{\circ} 27'$ . North of latitude  $35\frac{1}{2}^{\circ}$  the range comes sharply to the ocean in two or three

high, sharp, rocky plications, folds or ridges, with regular or irregular valleys between them; and *broken down* (1) at the Bay of Monterey in latitude  $36^{\circ} 36'$ ; (2) at the Golden Gate in  $37^{\circ} 49'$ ; and (3) at Bodega Bay in  $38^{\circ} 18'$ .

Inside of this coast range lies the Great Valley of California, having an average width of 65 miles, 450 miles in length, and bounded on the east by the Sierra Nevada.

The *ocean face* of the coast mountains is high, rocky, bold, and grand in certain parts, for example: one of the Twin Peaks of the Santa Lucia range in latitude  $36^{\circ} 03'$ , rises to 5100 feet only three miles from the sea; Mt. Santa Lucia about ten miles east, with deep intervening valley, rises to 6100 feet; Loma Prieta (formerly Mount Bache on Coast Survey charts) is in the San Francisco Peninsula range in latitude  $37^{\circ} 07'$  and reaches 3793 feet above the sea; Tamalpais Mount in the range on the peninsula north of the Golden Gate in latitude  $37^{\circ} 55'$ , and only four miles from the sea, is 2604 feet high. To the westward of this mountain is the outstretching Point Reyer Head 597 feet high, stretching eight miles beyond the general direction of the coast and connected therewith with low-lying alluvial lands.

North of Bodega Head ( $38^{\circ} 18'$ ) the general height of the range is 2200 feet, until within twenty miles of Cape Mendocino, it reaches 4265 feet at Krag Peak latitude  $40^{\circ} 09'$ .

Beyond Cape Mendocino ( $40^{\circ} 27'$ ) the range is continued under the sea, as shown by a few deep sea soundings. It is here that ships have experienced the effects of submarine earthquakes.

The greatest *transverse line of rupture* in these ranges is the Golden Gate, one mile wide and sixty-three fathoms deep. A less but longer line of *low rupture* is from Bodega Bay to Petaluma Creek that empties into the northwest part of San Pablo Bay.

*Ocean Depths.*—Off this bold and rocky coast the profound depths of the Pacific lie close aboard.

In 1874 Captain George Belknap, U. S. Navy, ran several lines of deep sea soundings broad off certain points of the coast to the depths of 1000 and 2000 fathoms, so that we know the depth of 1000 fathoms is found at 40 to 60 geog. miles from shore and the deep plateau of 2000 fathoms,  $2\frac{1}{4}$  miles, at 46 to 72 geog. miles. The shortest distance is off the Santa Lucia range: the middle off the Gulf of the Farallones, and the longest off Cape Mendocino. At the latter the 1000 geographical miles sounding was gotten at 25 miles; and the 2263 sounding at 85 miles.

And it should be noted that off the high bold coast just south of Cape Mendocino there are *four submarine, or submerged valleys* that head directly at the shore under the highest peaks, and at right angles to the coast. (See my paper on Submerged Valleys.) Those are the more general features of the coast line. The coast survey charts exhibit the line of coast, the heights, and the depths.

*The Bay of San Francisco.*—This bay lies in one of the valleys of the coast range, and therefore is mainly parallel therewith; and the great transverse break through this range helps to form the bay.

The line of Suisun Bay, Karquines Strait, San Pablo Bay, and the Golden Gate is the course of the drainage of the Great Valley of California, and the adjacent valleys. It is the natural highway of commercial activity between the interior regions and the Pacific.

The area of the Bay proper is 301 square miles, of which 83 square miles have four fathoms and more of water; San Pablo at the north has an area of 123 square miles, of which 17 square miles carry over four fathoms of water.

Both these bays are largely bordered by broad, low, salt marshes, cut by many sloughs. Inside of this marshland (which marks the shoreline of high water) the low, alluvial soil may be from one to six miles wide, to where it joins the foot of the rocky ridges. In places the rocky points reach into deep water.

Some of these features are well shown on the coast survey chart "*Entrance to San Francisco Bay*"; and Professor J. D. Whitney's map of San Francisco Bay (1873) will give a general idea of the confining ridges; and the cross breakings.

There are two features that are particularly noticeable: (1) the subordinate valley running from Bodega through Tomales Bay and Valley to Bolinas Bay. The heights on the southwest side of this narrow valley reach 1356 feet in height; and on the northeast reach 1500 to 2604 feet.

(2) On the prolongation of this valley, across the Gulf of the Farallones, there commences a narrow valley about six miles below Point Lobos, and stretches southeastward, as a line of depression on the east side of the crest line of the Peninsula of San Francisco range, for thirty-six miles in a direct line. In this long stretch lie several small lagoons, and the Cañada de Raymundo where the Spring Valley Water Company has its main reservoirs. Of course the bottom of this valley is alluvial soil. The water company has two reservoir dams across it, and a third at the exit of drainage through San Mateo Creek or Cañon to the bay on the east. Neither of these dams is reported injured. Professor Branner, of Stanford University, has found some earthquake crevices in the line of depression. No rock rupture is reported there.

With regard to alluvial soil, it is well to bear in mind the relation of this whether in the valleys or around the bay and ocean shores, and the relation thereof to the rocky base upon which it rests or abuts.

I was one of the committee of investigation of the 1868 earthquake, and it demonstrated that the *course of greatest dislocation at the surface of the ground was on the line of contact between the "made" land or the alluvial soil with the rocky stratum.*

This is repeated in this earthquake, and therefore we make a few more remarks upon the bay shore line of San Francisco.

In the vicinity of the city proper, and within the area of the "City and County of San Francisco" (42.8 square miles), there are several indentations of the shore between rocky points. (1) Buena Cove, where the present "city front" or shipping point lies on "made" ground; (2) Mission Bay, Creek and Lagoon, being filled in; (3) Islais Creek, farther south.

In Buena Cove the mud has been found ninety feet deep; in Mission Creek ninety-six feet. The "filling in" has been sand, the waste of the city, and occasionally rock. To erect buildings thereon piling must be driven to "hard pan." In Mission Creek this has rarely been done; and therefore we must expect to find, and do find the greatest dislocation in such areas, and at the contact with fast land.

The towns of Redwood, Palo Alto, San José, etc., are built on the alluvial soil immediately inside the marshland, and are probably twenty feet above the bay.

These places and others about the bay show large destruction of property.

Up the Valleys of Petaluma and Napa similar results are presented.

On the rocky parts of San Francisco the horizontal resultant movement was three to four inches, on the "filled" in land near the new Post Office, the building, piled upon a clay foundation, suffered but little, while the street in front, made upon twenty-three feet of sand over a marsh, sank two feet and slid out from the building about one and one-half feet.

*Area of Disturbance.*—The Committee appointed by the Governor to gather data is doing what it can to define the locus of principal action, and the extent and direction of the lines of disturbance.

In my early inquiries I learn of injury to the Light House at Point Arena, latitude  $39^{\circ} 00'$ , 110 miles from San Francisco, and at "landing places" on the coast this way; damage fifty to sixty miles up the Petaluma and Napa Valleys; movement in the Yosemite Valley, 175 miles from San Francisco; and damage at Carmel Bay south of Monterey, ninety miles from San Francisco.

Up the Napa Valley material was thrown to the west-southwest; at Yosemite motion east and west; at Carmel Bay material to east; at Carson, Nevada, first movements nearly east and west, distance 180 miles to north-east, ended in several tangles.

At San Francisco movement from north to south, then east and west; and a final series of reverberations too puzzling to decipher. I judged these shocks to be about three or four per second.

There are reports of crevices in the west slope of the hills north of Berkeley; in the Cañada de Raymundo, with depression on one side; and on the outer coast at Half Moon Bay, twenty miles south of San Francisco; and at Bolinas Bay ten miles north of the Golden Gate. But all are in alluvial soil.

*Vessels at Sea.*—The action upon vessels in the Gulf of the Farallones, off the entrance to the Golden Gate, has been given me by Pilot Hayes. The Pilot boat Gracey S. was lying in eighteen fathoms off the light ship, ten miles from the Head of the entrance to the Golden Gate, and shivered as if the chain were running through the hawse. When the pilot boarded the German ship the captain told him he thought his vessel was on the rocks; and a second pilot boat thought that she was upon the rocks.

This striking and shivering of the ship has been felt many times off the northwest of Cape Mendocino, or the prolongation of that range.

That is a very unequal description of the region affected by the earthquake and its results. When we get a coherent report, a copy will be sent to the Society.

I wish in conclusion to say a few words of the conflagration that covered an area ten times greater than that of 1666 in London, with a vastly larger proportion of loss.

1. The electric power lines running to hundreds of industrial plants in the city are believed to have been broken, and that a fire was started at each break as if by magic. All the city fire engines were called out but *found no water*.

2. Where the 30-inch main crossed the "made" or "filled" in land at the head of the old Mission Lagoon, there was a sinking of the material, and the joints were drawn asunder at a drop of several feet. Therefore the main supply was unavailable; and the reservoirs ran to waste. Then the water was pumped from Lake Merced; and finally some repairs were made and the water was gotten to help the dynamiters when the fire had really crossed the wide Van Ness Avenue. The Claus Spreckels brownstone mansion on the west side stopped its progress to the northwest.

At our elevation of 340 feet we got *no water* for two weeks; no lights except candles yet; no fires in houses; and the people are cooking in the streets; rich and poor.

That is the gist of the matter so far as I can gather without having official authority. We expect much from the Light House Board; from Coast Survey tidal observations, and other sources.

*Area* of the burned district.

4 square miles; say 2560 acres  
London 436.

490 blocks

and probably 25,000 houses

SAN FRANCISCO, May 10, 1906.

This letter was discussed by Prof. W. B. Scott.

The following papers were read:

"The Nutritive Requirements of the Human Body," by Prof. Francis G. Benedict, which was discussed by Professor Houston, Professor Haupt, Mr. Wilcox, Mr. Goodwin and Professor Scott.

"A History of the Major Classification of the Mammalia," by Prof. Henry F. Osborn.